

## HIGH PRESSURE SENSOR

### Background

5 High pressure sensors used in diesel automotive fuel injection line applications must seal pressures up to 1800 Bar, and should provide for flexibility in the mounting and orientation of the part so that they are economically usable in a variety of vehicles. High pressure sensors should provide a reliable seal without requiring high torques that can lead to early failure. Part count and weight reduction are also important to reduce assembly costs and total vehicle weight. Current high pressure sensors typically lack in one or more of these aspects.

### Brief Description of the Drawing

15 The present invention is illustrated by way of example and not limitation in the accompanying figures, in which like references indicate similar elements, and in which:

FIG. 1 is a cross sectional view that shows a high pressure sensor in accordance with the preferred embodiment of the present invention.

20 Elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help to improve understanding of embodiments of the present invention.

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### Detailed Description of the Drawings

The present invention resides primarily in combinations of apparatus components related to the high pressure sensor. Accordingly, the apparatus components have been represented where appropriate by conventional symbols in the drawings, showing only those specific details that are pertinent to understanding the present invention so as not to obscure the disclosure with details that will be readily apparent to those of ordinary skill in the art having the benefit of the description herein.

Referring to **FIG. 1**, a cross sectional view of a high pressure sensor mounting configuration **100** in accordance with the present invention is shown in accordance with an embodiment of the present invention. The high pressure sensor mounting configuration **100** comprises three parts: a cylindrical pressure sensor cavity **105**, an internally threaded collet **170**, and a housing **160**. The high pressure sensor mounting configuration **100** is intended to conveniently mate with a pressure port **140** of a fluid distribution system of an engine in a vehicle or other situation, such as a fixed generator. The high pressure port **140** has the same port design as other pressure ports typically used currently in many diesel fuel vehicles. The pressure port **140** comprises external threads **135**, a cavity **145** that conveys fuel at an operating pressure, e.g., up to approximately 1800 Bar, and a concave conical mating surface **150**. The external threads **135** and concave conical shaped mating surface **150** are common with other pressure ports commonly used in diesel vehicles for fuel distribution. The aspect of being designed to mate with the type of pressure ports commonly used in today's diesel vehicles is a desirable aspect to customers who then do not have to make the fuel distribution units (also called fuel rails) with a unique pressure port for the pressure sensor, as must be done for many conventionally available pressure sensors.

The cylindrical pressure sensor cavity **105** is a single piece part that comprises a first bearing surface **115** that has a first angle, a flange **120**, a groove **125**, a sensing component **108**, an electrical contact **109**, and a pressure cavity **107**. The internally threaded collet **170** is a single piece part that has a second bearing surface **175** that has a second angle, and internal threads **180**. The cylindrical pressure sensor cavity **105** also comprises a convex or concave conical open end **110** having a third angle **113** (**FIG. 1** illustrates the open end having a convex shape). The housing **160** is a single piece part that comprises a wall **165**. The second contact surface **175** of the collet **170** bears on the first surface **115** of the sensor cavity **105** when the collet **170** is threaded onto the pressure port **140**, causing the convex conical open end **110** to contact on the concave conical mating surface **150** of the pressure port **140**, or, when the open end **110** is concave, the concave conical open end **110** contacts a convex conical mating surface **150** of the pressure port. The first and second angles are designed to provide a line contact

between the collet **170** and the sensor cavity **105**, and the third angle is designed to provide a line contact between the sensor cavity **105** and the pressure port **140**. The first, second, and third angles are designed to provide the line contact even when there is some small amount (e.g., up to one degree) of axial misalignment between the sensor cavity **105** and the pressure port **140**. The use of a line contact to transfer the force from the collet **170** to the sensor cavity **105** and the line bearing to achieve the pressure seal at the pressure port **140** allows the pressure seal to be made with substantially less force than those needed in conventional high pressure sensors that have flat packing or washers. The sensing component **108** is a silicon piezo-resistive transducer component that responds to deformation of the top surface of the cylindrical pressure sensor cavity **105** caused by high pressure inside the sensor cavity **105**. The strain sensing component couples an electrical signal through the electrical contact **109** to a mating connector (not shown in FIG. 1) and, ultimately, to an engine controller or electrical system. It will be appreciated that other types of sensing components and electrical coupling techniques could be used with the cylindrical pressure sensor cavity **105** to provide many of the benefits of the present invention, but other components and techniques may negatively affect the reliability or number of components that are assembled to form the high pressure sensor **100**.

The high pressure sensor **100** of the present invention is easily assembled by placing the collet **170** over the sensor cavity **105** and then affixing the housing **160** to the flange **120**, for example by welding or otherwise adhering the wall **165** to the top surface of the flange **120**, to capture the collet **170** onto the sensor cavity **105** while still allowing axial movement of the collet **170**. The housing may be made of metal or from another material compatible with the environment of the fuel distribution system. Once assembled, the high pressure sensor **100** of the present invention has no loose parts that can be lost, unlike many conventional high pressure sensors. Although a flange is used in the preferred embodiment to affix the housing **160**, other configurations may be used to capture the housing **160**. For example, the housing might be made of a material (metal, plastic, or other material) that had a cutout for a groove, wherein the material of the housing **160** flexes apart sufficiently while being pushed down over the pressure cavity and snaps into the groove. (When

a fixed radial orientation of the housing is important, the groove may have non-grooved segments and the cutout of the housing **160** may be shaped correspondingly). Such alternative configurations may be useful in situations in which the environment of the high pressure sensor is less extreme than vehicular engine mounting environments. The housing **160** is a housing that captures the electrical connector (not shown in FIG. 1) that mates to the electrical contact **109**, and also protects the mated connection from aspects of the environment around the high pressure sensor **100**.

The groove **125** is used in an embodiment of the present invention in which a strain gauge type of sensing element is permanently bonded to the body of the sensor cavity **105**. The groove **125** reduces strain measurement errors that could otherwise occur. It is located above a neck **111** of the sensor cavity **105**.

The collet **170**, the pressure sensor cavity **105**, and the housing **160** are made of stainless steel in the preferred embodiment of the present invention, but other materials could be used in other situations, such as non-vehicular applications (particularly for the housing **160**), or lower pressures (particularly for the collet **170** and pressure sensor cavity **105**).

It will be appreciated that the high pressure sensor **100** described herein can seal pressures up to at least 1800 Bar, provides for flexibility in the mounting and orientation of the high pressure sensor such that it is economically usable in a variety of vehicles. Due to the line contact types of seal achieved by the high pressure sensor **100** a reliable seal is provided without requiring high torques that can lead to early failure. The part count and weight are both less than in conventional high pressure seals.

In the foregoing specification, the invention and its benefits and advantages have been described with reference to specific embodiments. However, one of ordinary skill in the art appreciates that various modifications and changes can be made without departing from the scope of the present invention as set forth in the claims below. Accordingly, the specification and figures are to be regarded in an illustrative rather than a restrictive sense, and all such modifications are intended to be included within the scope of present invention. The benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur or

become more pronounced are not to be construed as a critical, required, or essential features or elements of any or all the claims.

- 5       As used herein, the terms "comprises," "comprising," or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. The terms "including" and/or "having", as used herein, are defined as comprising.

What is claimed is: